US006477582B1

(12) United States Patent
Luo et al.

(10) Patent No.: US 6,477,582 B1
(45) Date of Patent: Nov. 5, 2002

(54) METHOD AND APPARATUS FOR CONSERVATIVE LINK SELECTION

(75) Inventors: **Gang Luo**, Kanata; **Jianli Wang**, Ottawa; **Glenn Sutherland**, Kanata, all of (CA)

(73) Assignee: **Nortel Networks Limited**, St. Laurent (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/212,429**

(22) Filed: **Dec. 16, 1998**

(51) **Int. Cl.**[7] **G06F 13/00**
(52) **U.S. Cl.** **709/241**
(58) **Field of Search** 709/200–241

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,094,687 A * 7/2000 Drake, Jr. et al. 709/241
6,104,701 A * 8/2000 Avargues et al. 370/238
6,141,325 A * 10/2000 Gerstel
6,175,870 B1 * 1/2001 Gawlick et al. 709/227
6,189,043 B1 * 2/2001 Buyukkoc et al. 709/221

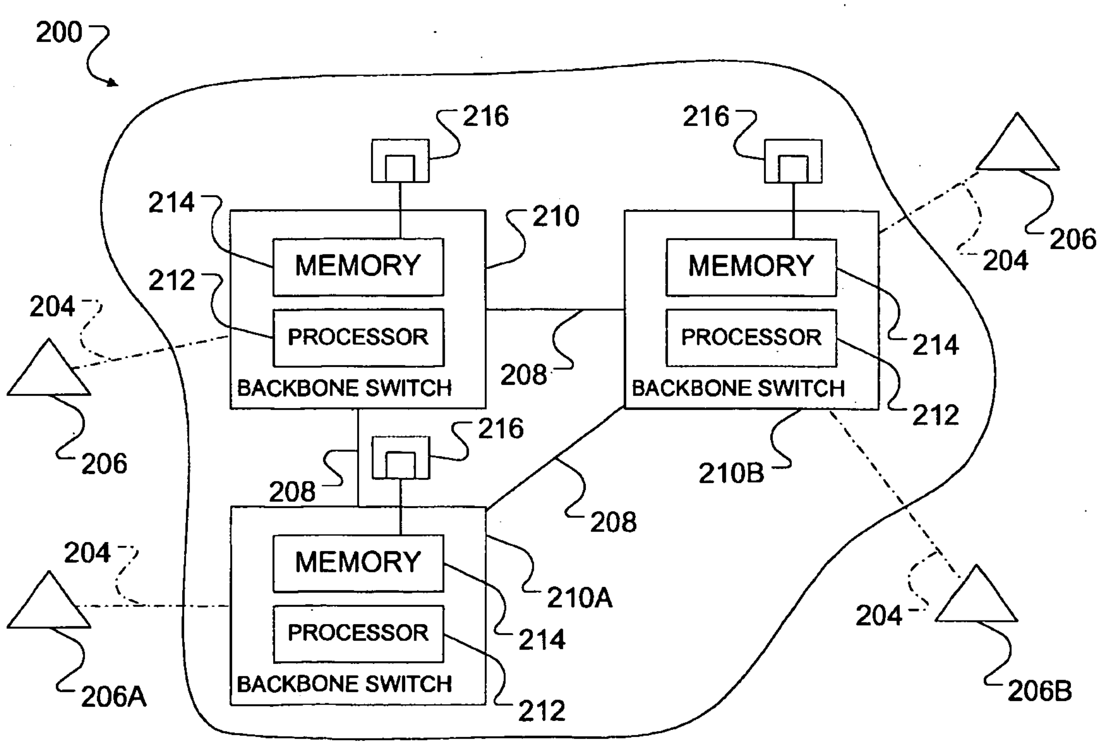
* cited by examiner

Primary Examiner—David Wiley
(74) *Attorney, Agent, or Firm*—Allan P. Millard

(57) **ABSTRACT**

A method is described for path selection in communications networks with multiple QoS metrics. This method takes an additive metric (say, cost) as a path minimization target and a concave metric (say, bandwidth) as a minimum requirement for each link. A potential objective is to find a path between a source node and a destination node in a communications network such that the bandwidth of each link in the path exceeds a bandwidth requirement and the cost of the path is minimized. The method eliminates from consideration those links whose available bandwidth does not exceed a required bandwidth. The method then reassigns the cost of those links whose available bandwidth does not exceed a function of the required bandwidth. A path from the source node to the destination node is then selected, using only links still under consideration, corresponding to a path wherein cost is minimized.

19 Claims, 8 Drawing Sheets



US-PAT-NO: 6477582

DOCUMENT-IDENTIFIER: US 6477582 B1

TITLE: Method and apparatus for conservative link selection

---------- KWIC ---------

Detailed Description Text - DETX (2):
In a network having nodes and links between the nodes, we define a concave metric A.sub.bW (i, j) and an additive metric C(i, j) for the link (i, j) between each pair of nodes i and j and two specified nodes, s (the source node) and e (the end or destination node). By way of example, the additive metric, C(i, j), may be the cost of the link (i, j) and the concave metric, A.sub.bW (i, j), may be the available bandwidth of the link (i, j). The objective is to find a path p(s, e) between the source node and the end node such that at least a minimum amount of bandwidth is available along the path and the cost of the path (which is the sum of link costs over the path) is minimized.

Detailed Description Text - DETX (3):
Referring to FIG. 1, which models a communication system 100 as a graph of nodes, the link (i, j) between each pair of nodes is shown to have an associated available bandwidth and cost.

Detailed Description Text - DETX (7):
Illustrated in FIG. 4 is a method for considering available bandwidth when performing path selection in an embodiment of this invention. For a particular link (i, j), if the required bandwidth is greater than the

available bandwidth
(i.e., R.sub.bW >A.sub.bW (i, j)) the link is eliminated
from the graph
(step 402). Otherwise (i.e., where R.sub.bW <A.sub.bW (i,
j)), if a
specified inflated value of the required bandwidth is greater
than the
available bandwidth, the cost of the link may be reassigned
to a higher value.
The value of R.sub.bW is inflated by taking a function of
same and comparing
this with A.sub.bW (i, j). Thus, if f(R.sub.bW)>A.sub.bW
(i, j), the cost
of link (i, j) is reassigned. For example, the cost
reassignment could be C(i,
j)=C(i, j)+k*C.sub.MAX, where parameter k may be determined
by simulation and
where C.sub.MAX is the cost of the greatest cost link in the
graph. Function
f(R.sub.bW) may be defined as follows: ##EQU1##